Machine Learning 6.867 - Project

December 9, 2015

1 Introduction

2 Mean-Field Variational Bayes

Mean-field variational Bayes is a method for approximating the posterior distribution. In general, we have unknown parameters $\theta_1, \theta_2, \ldots, \theta_n$ that we have priors on, and our objective is to find the joint distribution $p(\theta_1, \theta_2, \ldots, \theta_n)$. Assuming that our approximate distribution is in the family $Q = \{q : q(\theta_1, \theta_2, \ldots, \theta_n) = q(\theta_1)q(\theta_2)\ldots q(\theta_n)\}$, we find $q^* \in Q$ that minimizes the KL-divergence with p, i.e. $q^* = \min KL(q||p)$.

3 Markov-Chain Monte Carlo

To evaluate the quality of the covariance estimates produced by our method, we used Markov-Chain Monte Carlo (MCMC) as a benchmark for the "true" distribution of the logistic regression weights (w_0, w_1, w_2). `R`

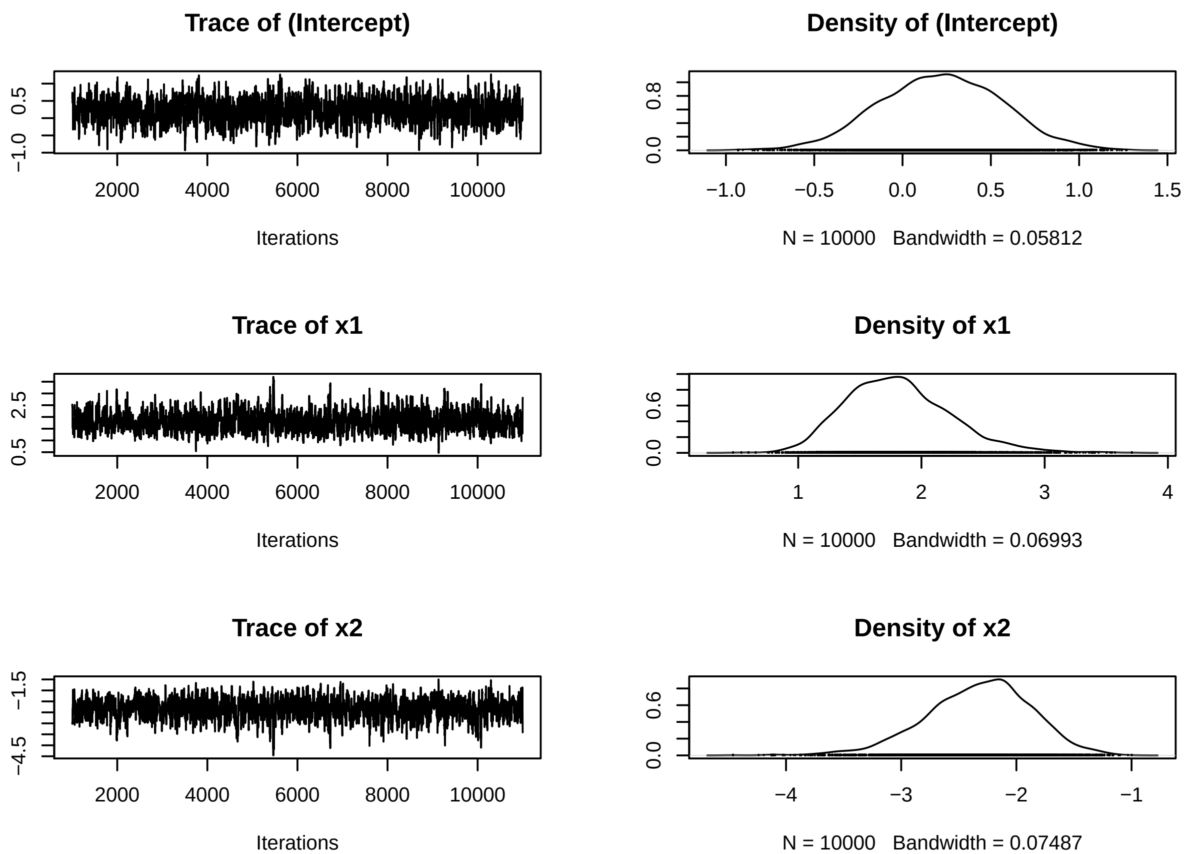

Figure 1: MCMC simulations of logistic regression weights for dataset 1, and corresponding marginal density plots, assuming an improper uniform prior. 10,000 iterations total.

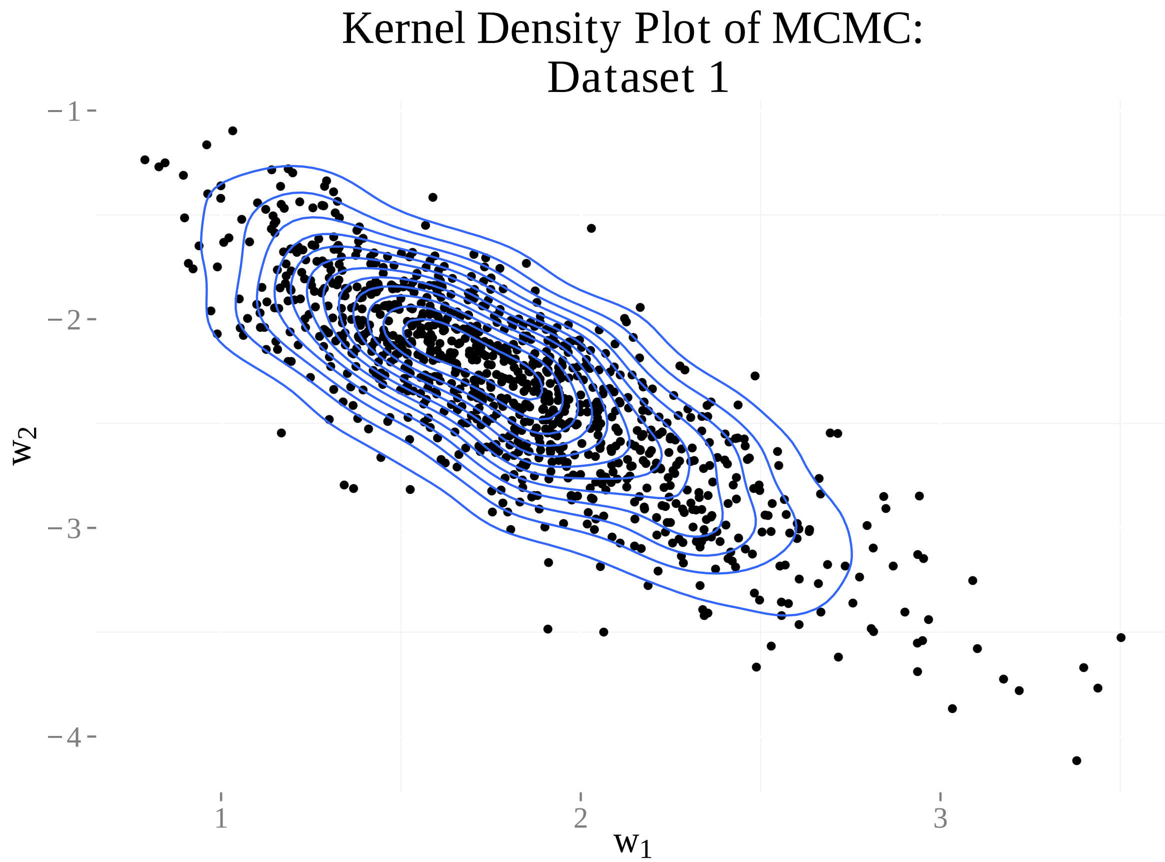

Figure 2: MCMC simulations of logistic regression weights for dataset 1, and corresponding kernel density plot, assuming an improper uniform prior. Subset of 1,000 out of 10,000 total iterations shown.

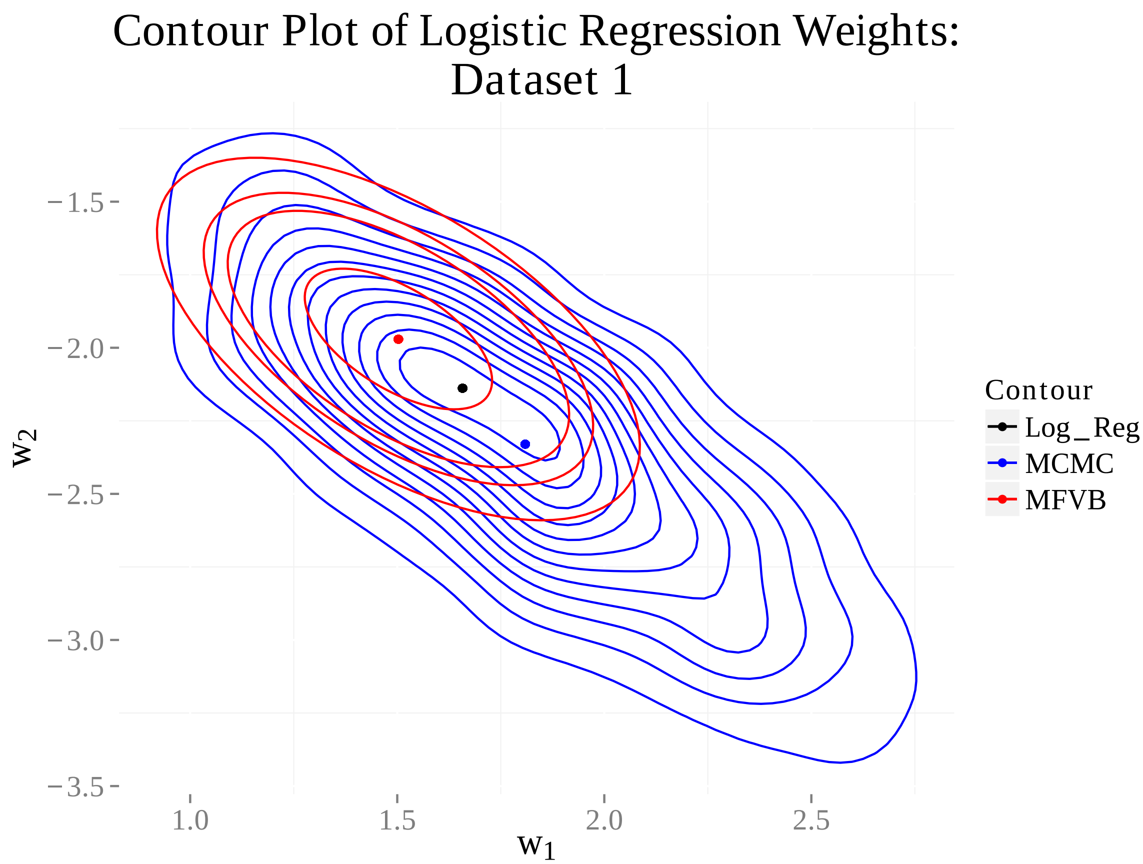

Figure 3: Comparison of logistic regression point estimate, kernel density plot of MCMC simulations, and posterior density of MFVB logistic regression (vectorized function), for dataset 1. Contours of MFVB logistic regression indicate 50%, 90%, 95%, and 99% confidence intervals for the bivariate normal $\mathcal{N}(\mathbf{w}_N, \mathbf{V}_N)$. Mean values for MCMC and MFVB are also included.